PSY3320 | Sleep and Circadian Rhythms

Week 1: Introduction to Sleep

1. Examine how sleep is measured, and understand which techniques are suited to different situations
2. Understand the different stages of sleep (sleep architecture) and what each represents
3. Comprehend the two-process model of sleep regulation
4. Understand the multiple functions of sleep
5. Critically evaluate how much sleep we ‘need'

Examine how sleep is measured, and understand which techniques are suited to different situations

Objective

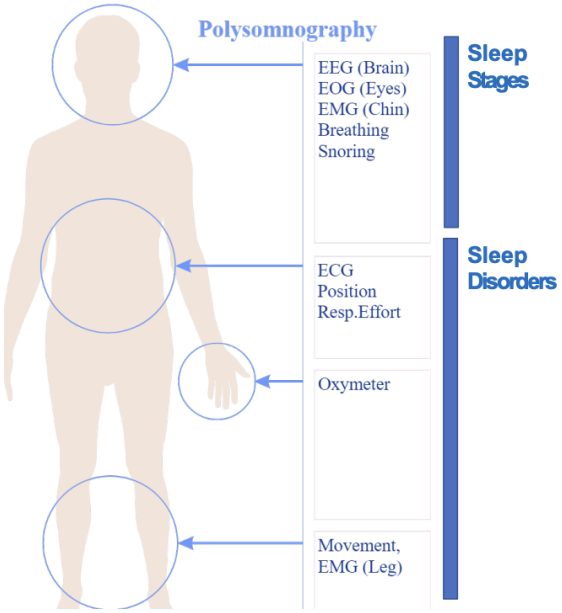
- Polysomnography (PSG)
    - Can do at home or lab
    - Measures
        - Sleep onset latency (how long it took to fall asleep)
        - Total sleep time
        - Sleep efficiency (how much time in bed was sleep)
        - Awakenings/WASO (waking after sleep onset)
        - Sleep architecture (can see hypnogram)
- Actigraphy (indirect)
    - Measures
        - Sleep onset latency (how long it took to fall asleep)
        - Total sleep time
        - Sleep efficiency (how much time in bed was sleep)
        - Sleep quality
        - Napping

Subjective

- Sleep diary
    - Measures
        - Sleep onset latency (how long it took to fall asleep)
        - Total sleep time
        - Sleep efficiency (how much time in bed was sleep)
        - Sleep quality
        - Napping

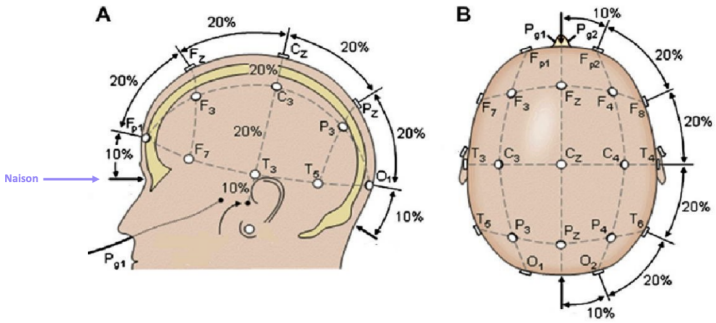
In-Lab PSG

- Electroencephalogram (EEG)
    - Examines what state the brain is in
- Electrooculogram (EOG)
    - Examines changes in eye movement in REM
    - Examines sleep onset and how it begins
- Electromyogram (EMG)
    - Examines muscle activity in REM



EEG

- Sensors placed on scalp picks up electrical activity in brain to measure brain activity to determine depth of sleep
    - EEG detects summation of synchronous activity of many neurons
    - Pyramidal neurons produce most EEG signals as they are aligned and fire together
- What does the EEG measure?
    - Captures change in signal as the cell changes from positive to negative
        - Post synaptic potential change in large population of neurons
    - EEG measures the difference in electrical potential between the pairs of electrodes on the scalp
    - Signals are amplified and filtered to make a digital recording
        - Y-axis: voltage (microvolts)-- how strong is the signal?
        - X-axis: time (seconds)--how quickly are the neurons firing together?
- Electrode Placement
    - International 10-20 Placement
        - Used to look at the location of the electrode relative to the individual



        -
    - Types of recording
        - Bipolar
            - Compare 1 electrode to another
        - Monopolar recording (recommended)
            - Have reference point (M1/M2: Mastroids)

- Looks at signals of an electrode relative to something that is quiet

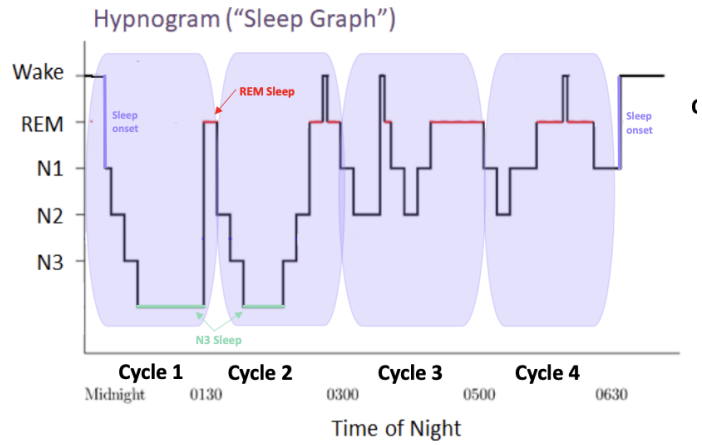
Understand the different stages of sleep (sleep architecture) and what each represents

Sleep Cycle: each cycle is 60-90 mins

1. N1: Light Sleep
    - Drowsy, sleep onset, stage transitions
2. N2: Moderate Depth
    - Sleep maintenance
    - Role in memory consolidation
3. N3: Deep Sleep
    - Memory and cognition
    - Physically restorative
    - Synaptic plasticity
    - Brain cleaning
4. REM: Active Sleep
    - Memory and emotional processing

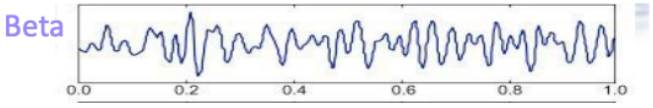
Hypnogram (Sleep Graph)

- More N3 sleep in first half
- More REM and N2 sleep in second half



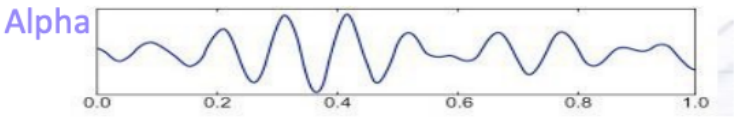
Sleep Macroarchitecture

- Amplitude and frequency (Hz/second or Cycles/second)
    - Brain waves
        - Beta Waves: 13-29 Hz/cps
            - Alert waking activity, arousal from sleep
            - Sigma activity: 11-16 HZ sleep spindles

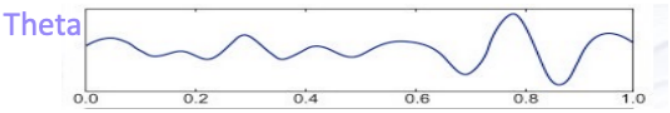


        - Alpha Waves: 8-12 Hz/cps

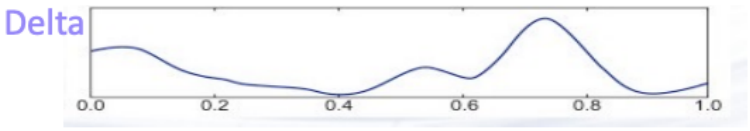
- Relaxed waking, eyes closed, arousal from sleep



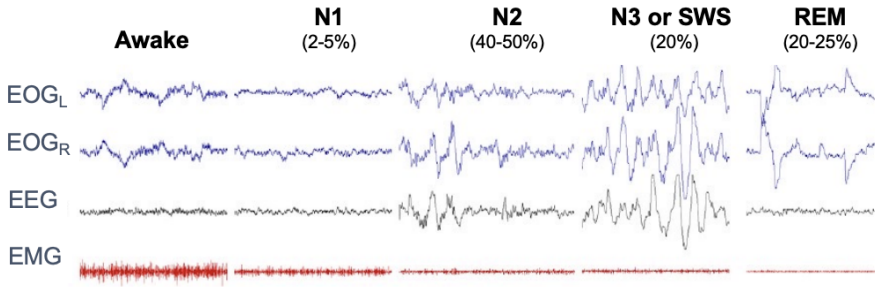
  - Theta Waves: 4-8 Hz/cps
    - Sleep onset, light sleep



  - Delta Waves: 0.5-4 Hz/cps
    - Deep sleep
    - Slow wave activity: 0.5-2 Hz minimum amplitude 75

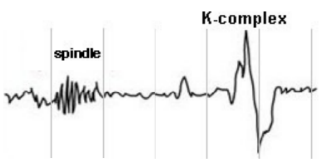


- Scoring Sleep–Sleep Staging
  - 30 second epochs that occur at the start of the study
  - If 2 or more stages coexist, assign the stage with the greatest portion of epoch



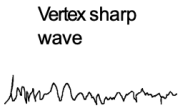
Sleep Microarchitecture

- Describes the wave form as a discrete event



Bursts of neuronal activity with a frequency range of ~11 to 16 Hz (usually 12–14 Hz) with a duration of 0.5 seconds or greater (usually 0.5–1.5 seconds).

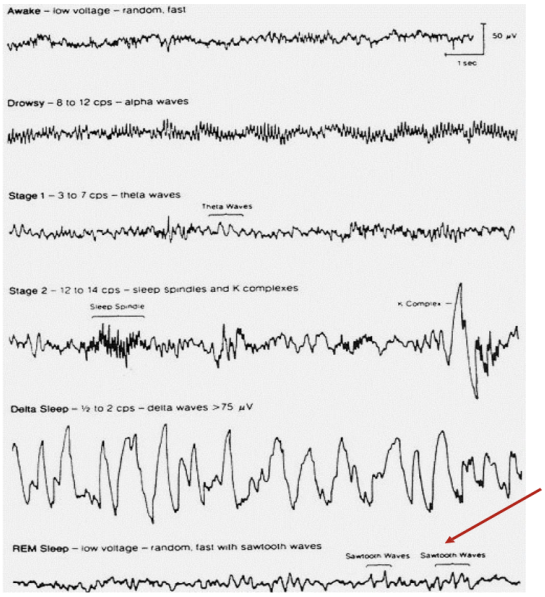
Sudden synchronous activity generating a large (>100μV), and slow (~1Hz) waveform.



Theta like wave (~8Hz or 100msec) seen at sleep onset, maximal at the vertex.

  - Spindle
    - Occurs in N2
    - Reflects memory consolidation and sleep maintenance
    - Indicates cortical development
    - Bursts of neuronal activity
  - K Complexes
    - Occurs in N2

        - Memory consolidation
        - Suppresses cortical arousal from external stimuli (avoid waking from distractions)
        - Sudden synchronous activity
    - Vertex Sharp Wave
        - Seen at sleep onset–indicates sleep onset
        - Theta like wave



Vigilant - Drowsy Wakefulness

EEG: Low amplitude/High-Mixed Frequency, Desynchronized/alpha activity
EOG: Blinking – SEMs emerge
EMG: **Noisy – high activity**

N1 Sleep

EEG: low voltage, mixed frequency; may be theta activity (4-7 Hz), vertex sharp waves
EOG: SEMs
EMG: Slight decrease from waking

N2 Sleep

EEG: Low voltage, mixed frequency (8-15 Hz) Sleep spindles, K complex.
EOG: Occasional SEMs
EMG: Tonic activity, slight decrease.

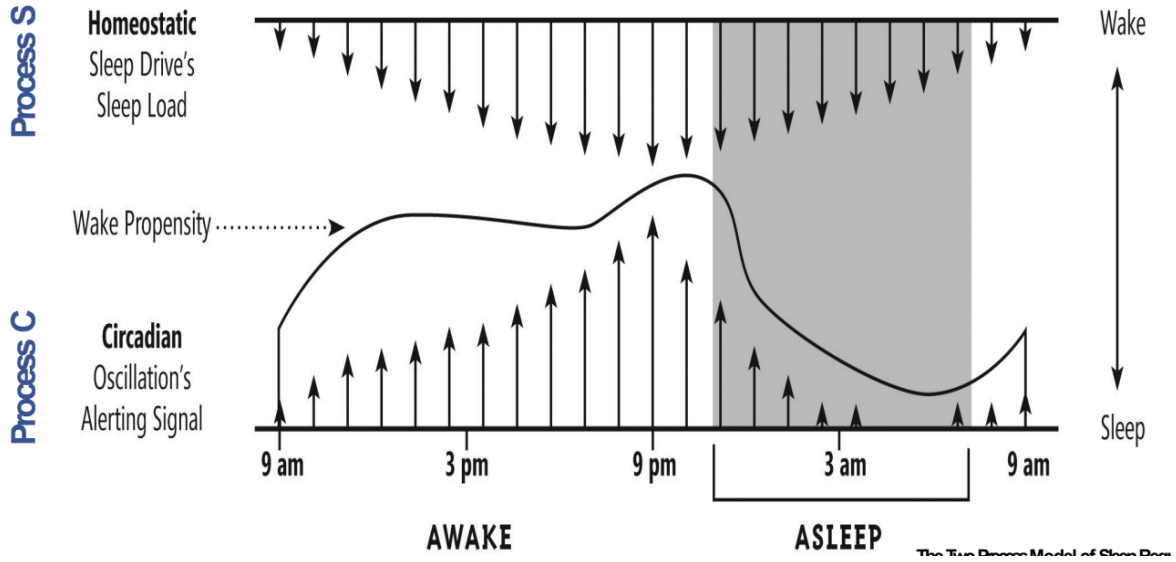
N3 Sleep

EEG: ≥ 20% high amplitude (>75μv) delta ≤ 4 Hz.
EOG: none
EMG: tonic activity, low level

REM sleep
EEG: low amplitude, mixed frequency.
EOG: REMs
EMG: low EMG tone (phasic twitches

Non-rapid eye movement sleep (NREM)	Rapid eye movement sleep (REM)
Slowing of brain waves	Reactivation of brain
Deep sleep, awakenings difficult	Fast, low voltage brain wave activity, muscle atonia, rapid eye movement
No recall of conscious experience	Inhibition of sensory input and motor output
Many autonomic and regulatory functions decrease e.g., heart rate, blood pressure, respiration rate	Inhibition and followed by postural shifts
Some neuroendocrine and neuroprotective activity increases e.g., growth hormone secretion and clearance of toxins (N3)	Muscle twitching, penile erection
	Many autonomic functions change e.g., fine control of temperature control and cardiopulmonary function is impaired
	Majority of dreaming occurs during REM sleep

Comprehend the two-process model of sleep regulation



Two-process model

- Model